

## **DUAL-INLET GEAR PUMP WITH UNEQUAL FLOW CAPABILITY**

### **BACKGROUND OF THE INVENTION**

**[0001]** This invention relates to a dual-inlet gear pump wherein a drive gear is configured to receive a higher flow volume than its associated driven gear. The invention has particular application in scavenging elements that pump an air/oil mixture from an oil sump in a jet engine, or from airframe or engine mounted gearboxes.

**[0002]** Jet engines, such as utilized in aircraft, include a lubrication system having an oil pump for moving lubricant from an oil tank to several components associated with the jet engine. In particular, oil is delivered to gear sets utilized to take power from the jet engine and drive various accessory functions. In addition, oil is delivered to bearings for the rotating components of the jet engines, which may include gearboxes.

**[0003]** Typically a scavenging pump is included to return the oil back to the tank from these several components. The scavenged oil is typically mixed with air when moved by the scavenging pump away from the component.

**[0004]** Gear pumps are one pumping mechanism utilized as the scavenging pumps. A dual-inlet gear pump as has been utilized in this application, has included separate inlets for delivering the air/oil mixture to two rotating gears, with a common discharge. The dual-inlet gear pump typically includes a gear rotated by a gearbox-driven input drive shaft, such as from the jet engine power plant. This first gear is known as the drive gear since it engages and drives a second, or driven gear. This known scavenging pump was utilized in an application where each gear received the same supply of fluid volume.

**[0005]** The jet engine environment is one where space is at a premium. Thus, it would be desirable to have the scavenging pump be as small as possible, and to operate as efficiently as possible such that its size may be reduced.

**[0006]** Dual-inlet gear pumps are known wherein separate inlets deliver fluid to the drive and driven gears. However, these prior art gear pumps are not associated with the scavenging pump on a jet engine, nor have they been utilized as efficiently as may be desired.

### **SUMMARY OF THE INVENTION**

**[0007]** A main feature of this invention is the inventors' discovery that in a dual-inlet gear pump, and in particular for one moving an air/oil mixture, the drive gear is able to move a higher volume of fluid than is the driven gear. This is true since residual air is trapped in a gear root, and expands to partially fill a tooth space on the driven gear as the gears rotate out of contact and toward a lower pressure inlet window in a pump housing. This gear tooth space volume is thus partially filled with carry-over air, and does not accept a full tooth space of new air/oil mixture from the inlet.

**[0008]** As a first embodiment of this invention, a method is disclosed for utilizing a dual-inlet gear pump that associates a first inlet for the drive gear with a higher volume flow and a second inlet for a driven gear with a lower volume flow. In disclosed embodiments and applications, the dual-inlet gear pump is utilized as a scavenging pump for a dry sump lubrication system in a jet engine. However, a dual-inlet gear pump having the higher volume flow directed to the inlet for the drive gear, and a lower volume flow directed to the inlet for the driven gear, would come within the scope of this invention, regardless of the particular application.

**[0009]** These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0010]** Figure 1 is a schematic view of the inventive dual-inlet gear pump incorporated into a jet engine.

**[0011]** Figure 2 is a cross-sectional schematic view through the inventive dual-inlet gear pump.

**[0012]** Figure 3 is a cross-sectional end view of the housing for receiving the dual-inlet gear pump.

### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

**[0013]** A jet engine 20 is illustrated schematically in Figure 1. As shown, a drive shaft 21 of the jet engine is powered by combustion, and driven to rotate. A main gearbox 30 takes this rotation and powers accessory components. Among the accessory components are an oil lubrication and scavenging pump 23 that delivers oil to and from gearbox 30 and its accessory components. Oil lubrication and scavenging pump 23 also delivers oil to and from bearings 22, 24, 25 and 26 for supporting the drive shaft 21, or other shafts. The main gearbox 30 drives an angled gearbox 28. Notably, the oil lubrication and scavenging pump's features (gear sets) and other accessory components are illustrated schematically. There may be a larger number of such components.

**[0014]** Oil is delivered by the lube oil pump 32 from an oil tank 31 to the engine and gearbox components. A scavenging pump 36 includes a number of separate gear sets 37,

which may receive a single inlet flow (here from components 22, 24, 25, 26). Further, a gear set 38 receives flow from two of the components 28 and 30, as illustrated schematically. As known, scavenging pump 36 applies a suction to the several components, and pulls oil from the components along with entrapped air. Thus, the fluid actually moved by the gear sets 37 and 38 includes a good deal of air mixed with oil.

**[0015]** As shown in Figure 2, the present invention utilizes a discovered operational feature of a dual-inlet gear set to provide more efficient operation. As is known, of the two gears in the gear set 38, drive gear 40 is driven, such as by a take-off power from the drive shaft 21. The drive gear 40 engages and drives the driven gear 42.

**[0016]** As shown in Figure 2, the present invention provides a first scavenge inlet 44 for the drive gear 40 and a separate scavenge inlet 46 for the driven gear 42. As can be appreciated from Figure 1, these two drive inlets communicate with two separate components 28 and 30.

**[0017]** As also shown in Figure 2, a shaft 70 drives drive gear 40, which in turn engages and drives driven gear 42. As mentioned above, the shaft 70 may be driven by the shaft 21 from the jet engine. Also, ports 45 and 47 communicate the inlets 44 and 46, respectively, into the pump chambers for the drive and driven gears.

**[0018]** As mentioned above, an inter-tooth volume trapped air 48 can re-expand as the teeth move out of engagement, and be trapped in a tooth gap on the driven gear 42. As the gears 40 and 42 continue to rotate, the teeth 60 and 63 on the gears 40 and 42, respectively, tend to move out of engagement. As this occurs, the air from space 48 moves into the tooth root space 61 on the driven gear 42. This air is trapped and continues to rotate with the driven gear 42 until it seals on a face or surface 65 approaching the inlet 46. As

tooth root space 61 approaches inlet 46, the entrapped air fills a portion of the volume, preventing the driven gear 42 from carrying as much fluid as it otherwise would be capable of providing. Notably, it is believed for this phenomenon to occur, the length of the surface 65 must be greater than the inter-tooth distance on the driven gear 42 such that the teeth seal on the surface 65, entrapping air in the space 61. It has been found that the overall capacity for fluid moved by the driven gear 42 is less than that of the drive gear 40. It is believed this is largely due to the entrapped air in the tooth space 48. In tests, there appears to be a difference in flow volumes on the order of 10-15%.

**[0019]** The present invention utilizes this recognition to attach the inlet 44 to the component 28, and attach the inlet 46 to a component 30, wherein the component 30 has a lower expected flow rate than component 28. In this manner, the two gears 40 and 42 more efficiently move the fluid from the components 28 and 30.

**[0020]** As shown in Figure 3, a housing 49 incorporates gear chambers 50 and 52 for receiving the drive gear 40 and driven gear 42. Housing 49 also includes the associated inlets 44 and 46 as explained above.

**[0021]** The present invention thus better utilizes a dual-inlet gear pump to more efficiently move a fluid from two distinct locations, wherein the two locations do not have equal flow needs. While the present invention is particularly useful, and is disclosed in a scavenging pump for a jet engine, other applications for a dual-inlet gear pump where there are two distinct flows will benefit from this invention.

**[0022]** While the application is specifically disclosed being utilized to move a fluid from gearboxes for a jet engine, scavenging pumps for other gearboxes can benefit from this invention. In particular, airframe-mounted gearboxes associated with an aircraft, but not

part of the jet engine, may also have particular application for this invention. Of course, other applications, such as bearings, may utilize the inventive arrangement.

**[0023]** Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.